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(SEE PAGE 13)

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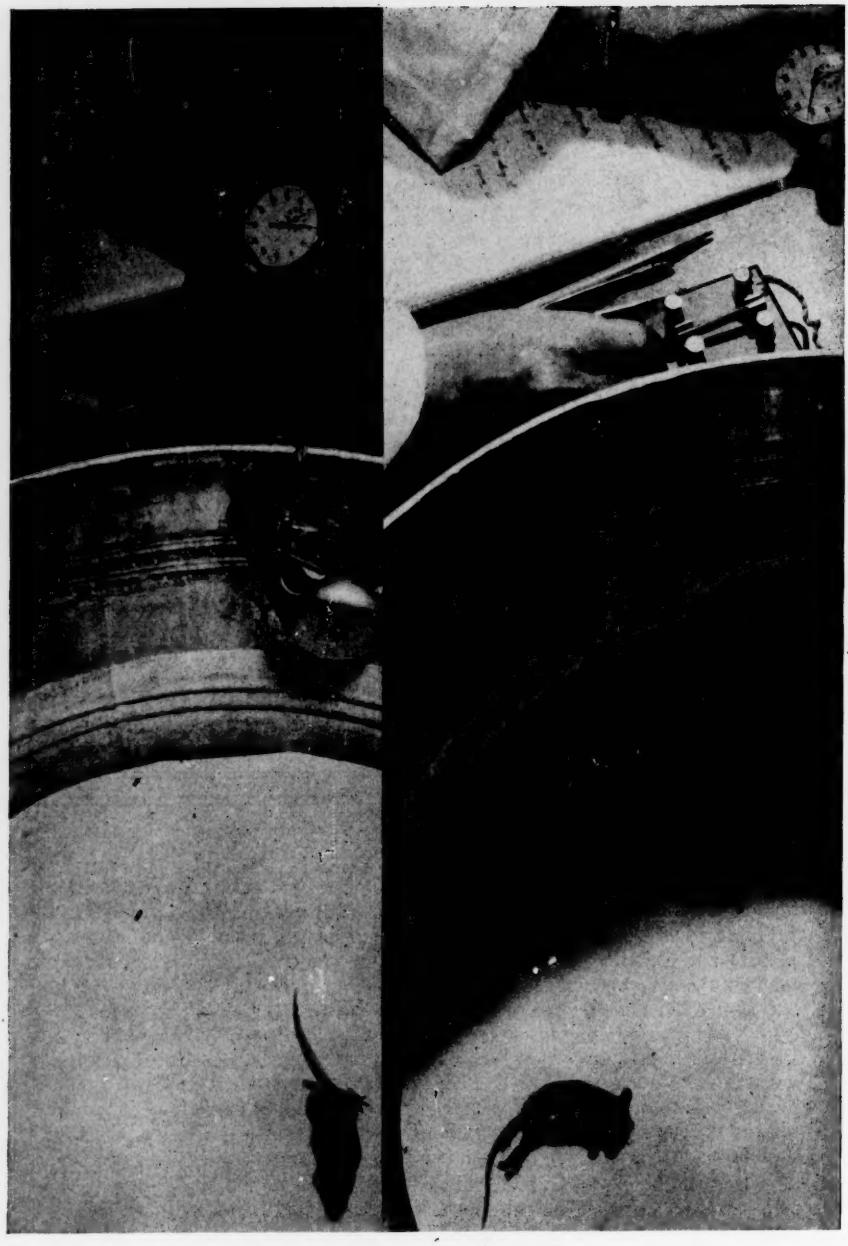


REACTIONS OF A dba MOUSE

Figure 1

Two views of a dilute brown (*dba*) mouse taken at intervals of about fifteen seconds. The doorbell attached to the tub is ringing, and in the first view the mouse is dashing madly to escape the noise. In the second view the mouse is dead.

GENETIC DIFFERENCES IN FATAL AUDIOGENIC SEIZURES

Between Two Inbred Strains of House Mice*

CALVIN S. HALL
Western Reserve University

THE present study consists of a comparison of audiogenic seizures in two highly inbred strains of mice. The term "audiogenic seizure" refers to a pattern of behavior which is elicited by auditory stimulation, such as an airblast, a Galton whistle, or the jingling of keys, and which is characterized by frenzied running terminating in convulsions. The pattern has been observed in rats and mice. One unusual feature of the pattern observed in the present study is that most of the mice did not survive the seizure. To the writer's knowledge this is the first instance to be reported of the widespread lethal effects of auditory stimulation. (Dice[4] observed one female mouse which died in convulsions.) In all other particulars, the behavior of the mice during the seizure mirrored that of the rats which the writer has previously observed.

Materials and Methods

Fifty-eight male mice from the Jackson Laboratory inbred *dba* and C57 strains were observed. There were 30 *dba* (Line 1) and 28 C57 (Line 6) mice and all were approximately 35 days of age at the time of testing. They were tested prior to sexual maturity but after being weaned. Both strains have been inbred by brother × sister matings for many generations so that the mice of each strain were genetically almost identical. The coat color of the *dba* is dilute brown non-agouti and that of the C57 black. The mice of both strains are raised under standard environmental conditions.

THE EXPERIMENTAL SITUATION

Figure 2

General view of the apparatus used in study of audiogenic seizures. After the mice have been in the tub, the bell is turned on, and the reactions observed. Nine out of ten *dba* mice die in convulsions in this apparatus.

The apparatus consisted of a round galvanized iron tub, 60" in circumference and 10½" high, and a doorbell hung on the inside of the tub, approximately four inches from the bottom. A 100 watt light hung about ten feet over the center of the washtub, so that no shadows were formed. (See Figures 1 and 2.)

*The data upon which this paper is based were gathered during the summer of 1946 while the writer was in residence at the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine. This work could not have been done without the cooperation of the members of the staff of the Laboratory. I want to express my appreciation to Dr. C. C. Little, Director of the Laboratory and Dr. J. P. Scott, Director of Behavior Studies, for their help and guidance.

SIX (DILUTE) BROWN MICE

Figure 3

These three photographs were taken in rapid succession at intervals of about a quarter of a minute. The bell started to ring about fifteen seconds before the first picture was taken. Two mice have ended frantic dashes to escape the sound with convulsive seizures which will end in death. In the next view one of the convulsed mice has moved, and another mouse is down. Continued ringing of the bell will not cause the surviving mice to go into convulsions. If they are exposed to the same ordeal after a day's rest, they are just as likely to be killed as a mouse exposed for the first time.

Each mouse was placed in the tub near the side opposite the bell. For the first two minutes the bell was not rung and the following records were obtained: presence or absence of defecation, wall-jumping and grooming, the number of times the mouse encircled the periphery of the tub and the number of times the mouse ventured out into the center of the tub. This constituted Period I. During the next two minutes (Period II), the bell was rung continuously and the following records were made: presence or absence of defecation, wall-jumping, grooming, freezing, hyper-activity, wild-circling activity, convulsions, and death. If the mouse survived Period II, the process was repeated once more. This procedure was carried on daily for four consecutive days.

Auditory stimulation was continued for only two minutes since it was found that if an animal does not convulse within that time, it will rarely convulse thereafter.

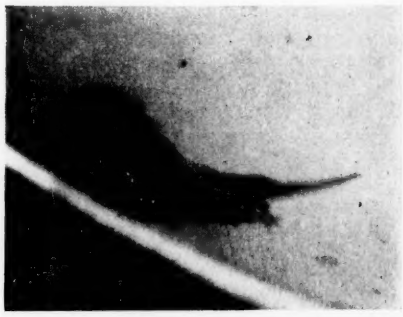
Results

The principal results obtained during Period II are presented in Table II.

With the exception of freezing and defecation there is a great difference between the two strains. All but two of the *dba*'s convulsed and only two of the twenty-eight survived the convulsion. The existence of a strain difference in behavior is thus established.

The contrasting behavior of the two strains during Trial I of Period I is summarized in Table I.

The *dba*'s are more active during their first encounter with the tub (bell off), while the C57's indulge in more grooming.



A MOUSE CONVULSION
Figure 4

The final convulsion of all mice experiencing fatal audiogenic seizures follows a remarkably similar pattern. The head is bent sharply down, and legs extended to the rear.

Discussion

The cause of death during convulsions is not known as yet although the work of Benson Ginsburg[7] suggests respiratory failure.

It may be categorically stated that the typical *dba* of this age and sex has an audiogenic seizure which terminates in death and the typical C57 crouches and freezes during the ringing of the bell.

Although only males were used in this investigation, additional observations on a number of females did not reveal any significant sex differences.

That susceptibility to audiogenic seizures is inheritable has been indicated by a number of experiments. Maier and Glaser[18] concluded that the trait as expressed in the rat is a simple Mendelian dominant, though in a later publication Maier[17] repudiated this conclusion in favor of a multiple-factor explanation. Griffiths[9] and Finger[6] present evidence for the complexity of the genetic pattern

TABLE I.—Reactions in Period I

	C57	*dba*
% defecating	75	63
% wall-jumping	0	30*
% grooming	85	43*
Average no. of times around the periphery of tub	2.11	4.93*
Average no. of excursions into center of tub	.53	1.63*

TABLE II.—Reactions in Period II

	C57	*dba*
Number of animals	28	30
% displaying		
a. hyperactivity	39	83*
b. wall-jumping	21	70*
c. wild circling activity	25	93*
d. freezing	93	96
e. defecation	95	80
f. convulsions	11	93*
% dying	7	87*

*These differences are at least three times the standard error of the difference.

underlying audiogenic seizures in the rat. Farris and Yeakel[5] find that gray Norway rats, descendants from the 43rd generation of captive animals reared under laboratory conditions, have more seizures than do those of the Wistar albino strain. Dice[4] and Watson[27] feel that these seizures (labelled by them "epilepsy") are a recessive trait in the deer mouse.

The present investigation was undertaken to demonstrate the difference in behavior of two inbred strains. It offers no evidence as to the nature of the genetic factors which control the trait. We hope that further studies may answer this question. That the trait is genetically determined and is not produced extragenetically during development is suggested by the following results. Three mice, 28 days old, who were descendants of *dba* fertilized ova transplanted into C57 foster mothers, were tested. All three mice convulsed and two died. Thus, they behaved like their true ancestors rather than their foster mothers.

For the convenience of interested readers, a list of studies of the influence of heredity on behavior is appended. While not pretending to be exhaustive, the list is believed to contain most of the major studies in this area. There are the selective breeding investigations of Tryon[25] and Heron[12] on maze learning, of Rundquist[20] on voluntary activity, of Hall[10] on emotionality and of Griffiths[9] on audiogenic seizures. All of these have used the rat. There are the studies of wildness and tameness in various strains of rats by Stone,[24] Yerkes,[28] Sadovnikova-Koltzova,[21] Utsurikawa,[26], Keeler and King,[14] and Rasmussen.[19] The same characteristics in mice have been studied by Coburn,[2] and Dawson.[3] Numerous neuromuscular disorders resulting from single gene mutations have been found in mice.[23] Other correlations between behavior and genetic constitution have been demonstrated by Keeler and Trimble,[15] for position preference in coach dogs, by Krechevsky[16] for "hypotheses" in rats, by Anderson[1] for activity of pure breeds of dogs and interbreed hybrids, by Scott[22] and Ginsburg and Allee[8] for fighting in inbred strains of mice, by Farris and Yeakel[5] for emotionality in gray Norway and Wistar albino strains of rats, and by Hall and Klein[11] for aggressiveness in rats.

Summary

Two inbred strains of mice, *dba* and C57, differ markedly in their susceptibility to audiogenic seizure. A high proportion of the *dba* strain convulse and die. Audiogenic seizures are rarely observed in C57 mice.

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THE MISSING FOREARM MUSCLE

A Case of Non-Familial Bilateral Absence of the Palmaris Longus Muscle in Man

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UNILATERAL and bilateral absence of the palmaris longus muscle in the non-human primates and in man has been the subject of many reports. According to Loth the muscle is always present in the prosimiae, in the Old World and New World monkeys, in the gibbon, and in the orang-outang, but absent in about 5 per cent of chimpanzees and 85 per cent of gorillas. In man there appears to be considerable divisional (racial), ethnic, and regional variation in the frequency with which the muscle is absent,—the muscle, in all groups, being more often absent in the female than in the male.

Table I will provide some idea of the variation in the absence of the palmaris longus in man.

The palmaris longus in man is the most variable muscle in the body. It is a muscle which arises at the medial epicondyle of the humerus, its short fleshy fusiform belly ending at the middle of the front of the forearm in a long flat tendon. This tendon passes over the flexor retinaculum at the palmar surface of the wrist, where it is therefore quite superficial and may readily be distinguished between the tendons of the flexores carpi radialis and ulnaris. When the hand is slightly flexed upon the wrist and the fingers flexed upon the palm the tendon generally stands out quite prominently, and is easily seen and palpated. It is a muscle, therefore, which readily lends itself to genetic study in the living. (See Figure 5.)

Inserted into the surface of the flexor retinaculum and the palmar aponeurosis the muscle is a flexor of the proximal phalanges, but owing to the differentiation of the other digital flexors in man and to the finer control of the movements of the fingers by the lumbricals and interossei the palmaris longus has become very much reduced, its distal portion particularly having become fused with the palmar aponeurosis in which it is represented as the radiate longitudinal fibers of the central portion of the palmar fascia. These longitudinal fibers are the remnants of distinct tendons which are now reduced to a tendinous fascia which, fan-like, spreads out in the palm to divide into five slips running to the base of each digit. These fibers are of interest in that their pathological thickening and contraction produce a puckering of the tissues of the palm and an intractable flexion of the fingers known as Dupuytren's contracture.

The slenderest muscle on the front of the forearm, the palmaris longus is of considerable interest from the phylogenetic standpoint, for in the great apes and in man it appears to be undergoing an evolutionary recession.

Action of a Dominant Gene

More than a quarter of a century ago Thompson, McBatts and Danforth conducted a genetic study of the variation of the palmaris longus muscle in 102 families totalling over sixteen hundred persons.[5]

In 69 families in which the muscle was bilaterally present, it was present in all but one of their 163 children. In 12 families in which both parents lacked the muscle on one or both sides, none of the 25 children had the muscle bilaterally present, and only two exhibited presence of the muscle at all.

These investigators concluded that the facts were tentatively best explained on the hypothesis that absence of the palmaris longus is due to a single, probably, dominant gene which acts as an inhibitor of the muscle's development, but that owing to the action of modifying factors the inhibition is frequently incomplete.

This would certainly appear to be a satisfactory explanation of the mechanism involved in many instances of absence of the palmaris longus, but there are other instances for which some other explanation must be sought. There seems to be more than one way in which the palmaris longus may be caused to fail to develop, and this may be seen in the following case report.

Possible Recessive Inheritance

A. F., American (Jewish) male, born 30 April 1926, exhibited complete bilateral absence of the palmaris longus muscle. Direct inspection of the forearms of his living relatives (paternal grandmother, mother and father, paternal uncle, and the subject's younger brother and sister) in every case revealed well developed bilaterally present palmaris longus muscles. The propositus was the only member of the family without these muscles.

The evidence presented by this case is, of course, hardly sufficient to enable one to draw any definite conclusion as to the hereditary mechanism involved. A dominant gene subject to the action of modifiers is not completely ruled out as an explanation, though in the present instance it appears to be unlikely. The

TABLE I. Absence of the Palmaris Longus Muscle in Man*

Group	Number of Subjects	Investigator	Per Cent Absent
Japanese (Kyoto)	373	Adachi (1908)	2.7
Chinese	136	Nakano (1923), Wagenseil (1927)	2.9
†Indians, Shennecock	100	Thompson, McBatts & Danforth (1921)	3.2
Japanese in general	884	Adachi (1910)	3.4
†American Negroes	636	Thompson, McBatts & Danforth (1921)	4.8
Negroes	120	Loth (1912), Vallois (1926	5.0
Berbers	114	Ribet (1929)	10.2
Russians	1400	Gruber (1878)	12.7
†American Whites	1201	Thompson, McBatts & Danforth (1921)	14.1
English	305	Thomson (1895)	18.0
Whites in general	4841	Loth	19.3
†Indians, Penobscot	202	Thompson, McBatts & Danforth (1921)	19.3
French	520	Le Double (1897)	25.4

*After Loth.
†Living subjects.

TENDON OF PALMARIS LONGUS MUSCLE

Figure 5

An interestingly variable muscle of the human body which helps to flex the base of the fingers. The arrow points to the tendon of the muscle at the wrist. Since presence or absence of the muscle is easily established it lends itself to genetic study.

operation of recessive genes would here seem to be a more likely explanation. Mutation is possible, but perhaps an unnecessary *deus ex machina.*

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✦

THE ENIGMA OF INDIA

During many centuries the people of India have been breeding with the irresponsibilty of codfish; their national sport, as this author points out,* is sexual play. Until the imposition of the *pax britannica,* Malthusian checks, often with an assist from corrupt, avaricious and cruel rulers, had relatively free play. In the 16th Century, India's population was (according to modern estimates) about 100,000,000. In the ensuing 300 years, it increased only fifty per cent. In the years from 1850 to 1947, it has jumped to approximately 400,000,000.

Increased irrigation, improved transportation and public health, and the growth of industrial areas, have all contributed to the population increase—under the protection (and exploitation) of the British. Millions are chronically undernourished, dying of slow starvation; other millions, from time to time, die dramatically and relatively suddenly, as famine outstrips such modern "improvements" as railroads and storage facilities. From Calcutta to Lake Success, Hindus variously threaten the rest of the world with dire consequences if it does not "come across" with more food —or whine that the world, and especially the British, owe them a living. The author of the present appalling little book goes to neither extreme though he inclines toward the latter. That through hundreds of years in which native rulers have flaunted their wealth before the rest of the world, the Indians have done but little to better their own lot, seems not to have occurred to him.

The book is appalling in two senses. Its description and analysis of India's population are very well done, and present a situation that is far more sickening than any of the emotion-splashed accounts I have read. In assembling and organizing this material, Dr. Chandrasekhar has made a useful contribution. But, as one reads, it is difficult to agree with Dr. Thompson that "the outlook is not hopeless."

This pessimistic conclusion is reinforced, especially as one reads the latter part of the volume, where solutions for the problem are sought. These solutions are so shockingly removed from the bilharzia-infested rice paddies, the stinking village tanks, the gentle whir of Anopheline wings, the worn-out eroded lands, that they might have been written by an American academic economist. The author attacks as a "false conclusion" the idea that the population density of India is very high and quotes that meaningless statistic "number-of-people-per-square-mile." *Effective density,* or the ratio between empty stomachs and cubic yards of *productive* earth, seems not to have entered his calcula-

*S. Chandrasekhar, *India's Population.* With an introduction by Warren S. Thompson. New York: The John Day Co. 117 pp. $2.00.

tions. Nor have the extremely variable patterns of rainfall and drought, that combine to make most of India a marginal agricultural region.

He proposes a number of reforms that have certainly improved living standards in Belfast and Minneapolis, though they have not been notably operative in South Boston, and he assumes that they will work. He apparently accepts as inescapable the determination of all good Hindus to produce a male heir, and ignores what this is doing to India's population dynamics. He recommends birth control clinics to utilize, apparently, present contraceptive methods, which are far beyond the reach of 60% of the population with a gross income of $9.30 per head *per year*. He states that India possesses one third of the world's cattle and advocates the increase of such uses as milk production, but ignores the fact that the "sacredness" of these animals keeps alive millions (cows not people) at the expense of vegetation that should contribute more than cow-dung fuel.

"More land," he writes, "must be brought under the plough and the cultivated land must be made to yield enough, not only to feed the whole country, but with enough margin to provide necessary amenities for those who would remain directly dependent on it." (As though all Indians, needing food and clothing, were not directly dependent on it!) He apparently cannot find, even with a series of TVA's that would be quite beyond the reach of such backward peoples, more than 432,000,000 acres of potentially arable land to provide "amenities" for 400,000,000 people, increasing at the rate of almost 14,000 a day! The author even maintains that "with the full utilization of all her waste lands and with increased efficiency of present tillage, India could support 447 millions." How such efficiency is to be achieved and by whom, *before* India's population exceeds this number, we are only left to guess.

The author's love of his compatriots, and concern for their welfare, is understandable and admirable. None of us can look forward with complacency either to the dramatic famines that are sure to come to this unhappy land, or to the continuance of the partial famine that keeps nearly a fifth of the world's people at a lower nutritional level than that of the German wartime prison camps. The British should be damned, it seems to me, not for having provided so "little" in the way of irrigation and transportation, but for having provided as much as they have—without Indian support in stopping the awful spawning. The ideal of both the British and the Indians seems to have been to keep more people alive in ever greater misery.

That India represents a demographic cesspool should be apparent to anyone reading this book. That it may be, in its period of industrial revolution, one of the major threats to survival of modern civilization, should be apparent to everyone who has watched the accumulation of similar, though much lower, pressures in Europe and eastern Asia. This is a book that should be read with respectful attention, or the first half of it should, by every member of the United Nations' Security Council.

WILLIAM VOGT

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SOME EXPERIMENTS WITH MELITTOBIA AND OTHER WASPS

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BECAUSE parthenogenesis and male haploidy bulk so large in their reproductive economy, the Hymenoptera or wasp-like insects offer a most fascinating field for study in genetics and cytology. They are, as a whole, a singularly isolated group. Even the most primitive living members, which are highly specialized, show no relationship to any other order, and the paleontological record, going back to the Upper Jurassic, exhibits no evidence of kinship with other fossil insects.

There are two large suborders of the Hymenoptera. The Chalastogastra, comprising the broad-waisted wasps, the horn-tails and saw-flies, includes the more primitive species, plant feeders with caterpillar-like larvae. Under the Clistogastra, the narrow-waists with maggot-like larvae, are found a great variety of types specialized in many different ways, in behavior and sex physiology.

In the gall-forming wasps and their relatives of the superfamily Cynipoidea, we find a group of species showing alternation of a bisexual generation with a purely female generation reproducing parthenogenetically. A second group of unusual interest is found among the parasitic wasps, or more properly parasitoids, for unlike true parasites they resemble predators, devouring their hosts. Among these may be mentioned three superfamilies,—the Ichneumonoidea or ichneumon-flies, the Chalcidoidea or chalcis-flies, and the Proctotrupoidea. (See Figure 7.) The latter group includes many minute species which parasitize the eggs of their hosts, and which show polyembryony or the development of many individuals from a single egg. Finally there are the aculeates or stingers. Despite the popular belief that all wasps sting, it is only among these that the ovipositor has been modified as a weapon of offense or defense. The stingers include ants and bees as well as wasps, but such a grouping is in a way misleading. Ants are often classified as one of the fourteen families of "wasps" included under the superfamily Vespoidea, while the bees make up five of the eight "wasp" families of the Sphecoidea. If by the word "wasp" is meant a stinging hornet, then surely an ant or a bee is much more waspish than is a parasitic wasp.

It is often supposed that the order Hymenoptera is characteristically made up of social insects, but this is a misconception. It is only among a minority of the stingers that social life has been developed. The stingers in turn make up a minority of the described species of the order, the vast majority of which belong to the non-stinging parasitoid groups.

Many species of Hymenoptera are completely parthenogenetic, made up of females alone or with an occasional male which takes no part in reproduction. In other species unmated females may produce both males and females in widely varying proportions. The entire order from the horn-tails to the stingers is characterized by male haploidy. Diploid males have not been found in nature but only in inbred laboratory stocks of *Habrobracon*, a genus of the ichneumonoid family Braconidae. Much genetic work has been done on *Habrobracon juglandis* (Ashmead) and the method of sex determination has been worked out in some detail. This species has proved to be excellent for such studies but it is inferior to many other wasps for cytological investigations.

Melittobia

Wasps of the genus *Melittobia,* belonging to the chalcidoid family Eulophidae have been bred for several years by Dr. Rudolph G. Schmieder. These wasps are easy to rear and have chromosomes larger in size and less numerous than those of *Habrobracon.* For these reasons, and because *Melittobia* is distantly related to *Habrobracon* and is very different in its habits, life history and natural sex ratio, it appears to be good material for genetic studies and should be investigated by way of contrast. Four species have been bred and studied considerably, and all are much alike in general appearance, habits and life history. They parasitize pupae of many different insects and inactive larvae such as those of the mud-dauber wasps. Mud-dauber larvae are flaccid and will not, therefore, disturb the eggs of this ectoparasite which are not attached to the host but are merely scattered about on its surface.

Because the *Melittobia* larva is small —less than two millimeters in length— and because hundreds of eggs are deposited by a single mated female, great numbers of offspring may be reared from a single large host larva. Only a few eggs, however, are laid by an unmated female and these are all male-producing. The first son to mature mates with the mother which then lays many eggs. Over ninety per cent of the large brood produced are females and thus the host larva is not wastefully consumed in the production of superfluous males. The few males in bisexual broods develop sooner than their sisters and sibling matings take place as the females mature, so that almost all of them become impregnated.

The sexes differ greatly both in color and in structure. Pigmentation of the male is predominantly brown, that of the female black. High temperature during development lightens color; low temperature darkens it, as in *Habrobracon.* The effect is more striking in the males which may thus be made to vary from buff to deep chocolate brown. Reduction of color in the females is shown especially along the sutures where yellowish bands appear. (See Figures 6 and 9.)

The male is brachypterous, walking about rather clumsily with his useless wing stubs held erect from his body. The wings of the females are normally held flat over the abdomen. They are not used for flight but to aid her in short hops which she takes when disturbed. Her usual method of progress, unlike that of the male, seems well-directed as she runs about in ant-like fashion.

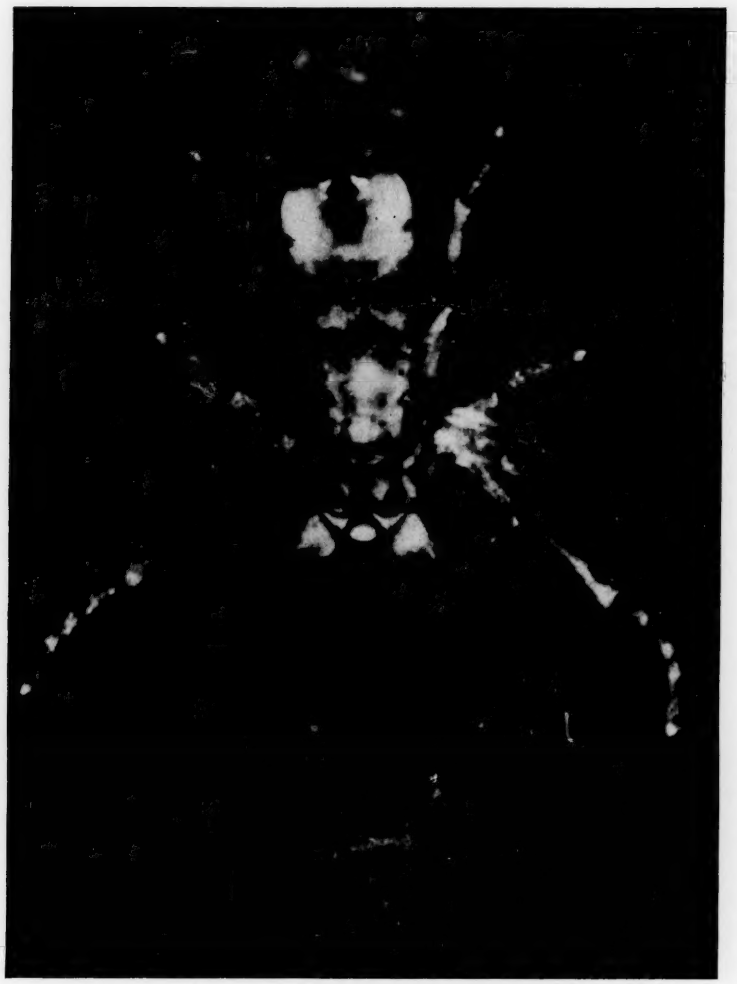
The eyes of the female are white in the young pupa, changing to pink and then to deep red in the adult. The male has minute pigment spots in place of compound eyes but prominent ocelli corresponding to those of the female.

Schmieder[4] has described a variant which is brachypterous in the female, with reduction of ocelli in the male, and with other differences from the type form. This second form, which develops only on fresh hosts and is determined by condition of the food, is incapable of migrating but serves in reproduction to increase the numbers of the type form.

The males of *Melittobia* are very belligerent, engaging in mortal combat with each other and often slaughtering females as well. Their antennae are modified for prehensile purposes. There is an extension from the side of the scape against the end of which the pedicel may be brought in contact, forming a sort of chela. Thus the male grasps the female by her antennae in the act of mating. These chelae are also used by the males in their combat with each other. A male was found with stubby male wings apparently growing from the scape of one of his antennae. However, this proved to be not an example of homoeosis but rather circumstantial evidence of vespicide.

Obtaining Male Broods in Melittobia

Schmieder[5] made pairings between different species of *Melittobia.* The females, thus mated, are stimulated to ovi-



MOTHER'S LITTLE HELPER—A CLUMSY MURDEROUS KIWI
Figure 6

In the male of Melittobia the eyes are reduced to minute pigment spots but the three ocelli stand out prominently as in the female. The two basal segments of the antenna are much modified and used as grasping organs in mating and fighting. The wings are very short and apparently useless. The males stalk about rather clumsily, threatening each other and often engaging in mortal combat. Only a small percentage of any brood is male, but these impregnate almost all of the females. ×65.

posit as freely as those mated to males of their own species. The foreign sperm were shown to enter the eggs, which then shrivelled with no hybrid offspring resulting. In this way, however, many haploid males were obtained from the small percentage of eggs remaining unfertilized.

A species of *Melittobia* as yet undescribed but designated species-C has been recently reared in shell vials, 20 × 70 mm., such as are used for *Habro-*

bracon. Host material, consisting of larvae and white pupae of various sphecoid wasps, has been kindly supplied by Dr. Schmieder.

Females may be obtained readily from bisexual broods, but study of a large number of males is desirable since these are haploid and may be expected, therefore, to show recessive mutant traits more frequently. In order to conserve host material and to avoid the laborious task of selecting the few males produced from among their sisters, an X-ray technique has been devised. A few males were selected from bisexual fraternities and heavily X-rayed (24,000 *r*-units or more) as young white pupae, older brown pupae or as adults. Because of their pugnacity it was necessary to isolate the adult males in separate capsules for raying. The treated males were mated to several virgin females and the females were thus stimulated to oviposit. Most of the eggs shrivelled as they had done in Schmieder's species-crossing. Nevertheless thousands of male progeny developed without a single sister.

Rearing Melittobia on Fly Puparia

A mud-dauber cocoon yielded fifteen parasitic fly puparia. These were exposed for a few days to *Melittobia* females and were then placed in separate vials. No flies emerged but all puparia yielded *Melittobia*. From one puparium which was broken there emerged 9 males and 17 females with two males and two females remaining in the puparium. From 13 intact puparia there emerged 346 females and only 5 males. Dissection of these puparia yielded 54 males and 30 females.

Evidently the first female to mature gnaws a hole in the puparium through which most of the females and a few males emerge. Mating can take place within the puparium, for an abundance of offspring were produced on mud-dauber larvae by the females from every puparium including those from which no males emerged.

The fifteenth puparium yielded females only, 28 emerging and 21 found inside. These virgin females laid only a few eggs, but after mating with their first sons to mature, they produced an abundant progeny, mostly females as expected.

Tests were made to determine whether *Melittobia* would parasititze the puparia of blow flies. About 50 mated females were placed in each of eleven vials with several puparia. No flies developed. The *Melittobia* females pierced the puparia walls with their stings, fed on the juices of the pupae and deposited their eggs within the puparia. Many thousands of offspring developed. The following counts were made: 343 females and 20 males from puparia that were broken, 2,405 females and 8 males from among the many emerging from intact puparia. Within several puparia examined several days after the wasps had emerged there were found 100 dead females and 82 dead males.

Unmated *Melittobia* females were set with 132 blow fly puparia. No flies emerged. Subsequent examination showed 22 with a few dead pupae or adult males of *Melittobia* and 110 with dead flies on some of which were a few shrivelled eggs.

Melittobia appears to thrive as well on puparia of blow flies as on those of the parasitic flies found in wasp nests.

Allergy to Habrobracon Poison (?)

The diet of *Melittobia* is very varied but, since its sting is unable to paralyze active larvae, its polyphagy is limited to pupae of various insects and to such larvae as are naturally inactive.

Several attempts were made to rear *Melittobia* on caterpillars of *Ephestia* moths which had been rendered inactive by the sting of *Habrobracon*. These were all unsuccessful for, although the *Melittobia* females fed and apparently thrived on the juices of the stung caterpillars and although many eggs were laid, these, for the most part, failed to hatch and the few larvae that appeared failed to develop. When the *Melittobia* females were returned to mud-dauber larvae, fertile eggs were immediately laid and normal offspring developed,

TINY TERROR OF FOOD-BEETLE LARVAE

Figure 7

This chalcidoid wasp, *Aplastomorpha calandrae* (How.), is a very common and now virtually cosmopolitan ectoparasite of beetle larvae infesting stored products. Head and thorax of the male (*A*) and female (*B*) are metallic green and black. The sexes differ greatly in the color of the abdomen which is black and heavily sclerotized in the female. A small larva of the tobacco beetle serves to nourish but a single larva of the parasite, so that the brood may be widely scattered. In this species outcrossing is the rule. ×35.

showing that the mothers had suffered no permanent impairment of fecundity.

Melittobia females were then set with *Ephestia* pupae and prepupae which they stung and upon which they fed. Eggs were laid in considerable numbers and larvae hatched but were, for the most part, unable to live. It was apparently impossible for them to obtain nutriment through the sclerotized pupal covering. Only those on the relatively soft prepupae were able to make any growth and most of these died as the pupal integument thickened. Finally, a few small *Melittobia* pupae were obtained from the *Ephestia* prepupae and from these eclosed six very small adults—four females and two males.

Since it is possible for *Melittobia* to develop on *Ephestia* prepupae their failure to do so on the paralyzed caterpillars is presumably due to some specific effect of the poison of *Habrobracon*.

Development of the pupae of the moths, as also of the flies, is stopped by the sting of *Melittobia* so that adults fail to eclose. The *Melittobia* female is able to penetrate the sclerotized pupal covering in both forms with her sting. She does not have to gnaw through the puparia either to obtain nutriment or to oviposit.

Sex Determination in Species with Haploid Males

In fraternities from closecrossed *Habrobracon* females sex determination has been shown[9] to be complementary. Females are heterozygous for sex, *xa/xb*, and different types of haploid males occur, *xa* and *xb*, indistinguishable phenotypically. Females may mate with either type of haploid male, producing daughters, *xa/xb*, and also homozygous diploid male-producing combinations, *xa/xa* or *xb/xb*, which are highly inviable. Mortality of diploid males occurs almost entirely before hatching, so that many bad eggs are laid by these mated females. Unmated females are, by contrast, much more fecund because their offspring are exclusively haploid males of good viability.

Diploid males occur among the progeny of closecrossed females only. In outcrosses between unrelated stocks, no diploid males are produced and the number of females is double that from the closecrosses. The highly inviable diploid males are therefore replaced by females. It has been shown[11] that, instead of a single pair of sex factors as in closecrosses, there is actually a series of multiple alleles with several types of haploid males—*xa*, *xb*, *xc*, etc., and an equal number of types of diploid males—*xa/xa*, *xb/xb*, *xc/xc*, etc. Any heterozygous combination — *xa/xb*, *xa/xc*, *xb/xc*, etc. — is female, so that outcrosses are likely to involve three alleles, *xa/xb* × *xc* for example. No diploid males are, therefore, produced but all fertilized eggs are heterozygous, female-producing.

The complementary scheme of sex determination may, at least tentatively, be extended to other hymenopterons and to the remaining groups of invertebrate animals with haploid males.[12] Multiple sex alleles would ensure that in species normally outcrossing most fertilized eggs would be female-producing and there would be little reproductive wastage through homozygous combinations. However, there are many species in which closecrossing is the rule and for these it is obvious that multiple sex alleles existing in the species would not persist within any one of the inbred lines composing the population.

The four species of *Melittobia* are examples of such natural closecrossing. The "selfcross" of the virgin mother to her first son produced on a newly found host must obviously involve only two alleles of any one series and the usual method of sibling matings between the offspring of a single mated female would also involve only two sex alleles unless the mother had happened to be outcrossed. Even in that case one-half of the pairings within the fraternity would be two-allele crosses. Such two-allele crosses would be expected to entail fifty per cent wastage of the fertilized eggs unless there is some type of non-ran-

INCESTUOUS INSECT

Figure 8

The male of *Telenomus fariai* has well-developed wings. Several of these minute black wasps may develop within a single egg of the host, the "barbeiro" bug. Sibling matings take place within the egg shell if both sexes occur in the brood, but outcrossing may take place between brotherless females and the sons produced in the male broods of virgin mothers. In the female the antenna is considerably shorter than in the male. ×65.

domness in syngamy—differential maturation for example. It is possible, however, that *Melittobia* may have some method of sex determination fundamentally different from that of *Habrobracon*.

Telenomus

Another naturally closecrossed species is the minute wasp *Telenomus fariai* (Lima) (Figure 8) of the family Scelionidae, a parasite on the eggs of *Triatoma*, the "barbeiro" bug, notorious as a vector of Chagus disease. Dreyfus and Breuer[1] report that in this wasp "daughters and sons of the same mother copulate before leaving the eggshell of the host. Despite the brother-sister mating, diploid males are unknown." From their cytological observations the authors conclude that the females are heterozygous for sex, XY. Differential maturation occurs so that the female pronucleus has always an X-chromosome as have the somatic cells and the early spermatogonia of the males. In the process of spermatogenesis the X is transformed into a Y by loss of a fragment, so that all spermatozoa have a Y.

Telenomus resembles *Habrobracon* rather than *Melittobia* in that unmated females lay a normal number of eggs from which haploid males develop. Failure to find diploid males among the offspring of mated females should not be taken as evidence against the *Habrobracon* system of sex determination. Lack of diploid males may merely mean their complete inviability. However, according to the principles established for *Habrobracon*, if no diploid males occur in a closecrossed species, one-half of the fertilized eggs should be inviable. Mated females should be less fecund than unmated. The fact that this appears not to be the case in *Telenomus* adds evidence to the cytological findings in favor of some type of non-randomness in fertilization to ensure reproductive economy. Since egg counts can not be made, however, in this egg parasite, viability ratios can not be determined. It is possible that mated females may lay more eggs in a single *Triatoma* host egg than unmated females so that numbers of offspring emerging may be equalized.

Reproductive Economy in Closecrosses

Proof that reproductive economy is high despite closecrossing has now been obtained through the egg count studies of Schmieder[6] on *Melittobia*. As already stated, *Melittobia* is an ectoparasite, scattering its eggs over the surface of the body of its host. The flaccid larvae of mud-daubers are favorable for egg counting, especially the large larvae of *Trypoxylon politum*.

It has been mentioned that most of the offspring of mated *Melittobia* females are daughters. Schmieder's data show that, in many broods from highly inbred females mated to siblings and even to their own sons, over ninety per cent of the eggs develop into females. Thus there are not enough unhatchable eggs remaining to constitute the homozygous diploid male-producing class expected according to the *Habrobracon* scheme.

What may be the method of ensuring reproductive economy in *Melittobia* and, indeed, what may be its method of sex determination are as yet unknown.

Some Comparisons and Contrasts

Schmieder[5] has studied gametogenesis and cleavage in *Melittobia*. No diploid males were found. Haploid chromosome number is five, diploid ten, as in *Telenomus*.

In *Habrobracon*, haploid and diploid numbers are ten and twenty. Diploid males have been identified by genetic tests, and chromosome counts have been made for material published under three specific names—*juglandis* (Ashmead),[8] *brevicornis* (Wesmael)[7] and *pectinophorae* (Watanabe).[2] The species upon which most of the work has been done, *H. juglandis* (Ashmead), is synonymous with *Microbracon hebetor* (Say), as *H. brevicornis* (Wesm.) is with *M. brevicornis* (Wesm.).[3] As regards *pectinophorae*, I quote from a recent letter from Dr. C. F. Muesebeck: "Watanabe sent me paratypes of his species *pectinophorae* shortly before the war, and although I have not studied these specimens minutely I believe them to be identical with *hebetor*. If not, they are exceedingly closely related, and will be very difficult to distinguish." The name *Habrobracon* has been restricted to a few closely related species under the genus *Microbracon*, but there is no satisfactory line of demarcation separating this group.

Although diploid males have been found in no hymenopterons other than *Habrobracon*, there is evidence that sex-homozygous types occur. Dr. Otto Mackensen of the Beeculture Laboratory, Louisiana State University, has made tests with the honey bee (unpublished) indicating that the *Habrobracon* scheme applies. He permits me to quote from a recent letter—"there is definite evidence of a series of lethal alleles in the bee which act as do the sex alleles of *Habrobracon* as far as non-hatchability of the eggs is concerned, except that they are completely lethal when homozygous. Tests, crossing homozygous recessive females to normal males, have been made in two stocks. No biparental males have been found, and we have no other evidence that the lethals are associated with sex. Experience in our breeding work suggests that these lethals may be present in all stocks."

Dozorceva[10] carried out genetic experiments with the chalcidoid *Pteromalus puparum*. A sex-linked recessive, red eye-color, was obtained. Pairings of heterozygous females by recessive males demonstrated three types of fraternities: (1) those (three-allele?) in which red- and black-eyed females were approximately equal; and (2) those (two-allele?) in which red females greatly exceeded black; or (3) the reverse. Recessive females were not crossed with normal males, so that diploid males, if they occurred, were not separated from their haploid brothers. *Pteromalus puparum* is a common parasite attacking pupae of the cabbage butterfly. It is naturally outcrossed so that multiple sex alleles would be of advantage in reproductive economy.

Taken by-and-large, the genetic and cytological work, while intensive on an exceedingly small minority of species of

FEMALE AND LARVAL MELITTOBIA

Figure 9

A—In general appearance the tiny *Melittobia* females much resemble ants. Their wings are not used for flying, but to aid them in short hops which they make when disturbed. They probably cling to the body of the host wasp in order to be conveyed to a new nest. *B*—Ventral view of a white female pupa of *Melittobia*. The mandibles are taking on a brownish color at this stage, and the eyes are pink, soon to deepen to red. *C*—Ventral view of a brown male pupa of *Melittobia*. The highly modified antennae extend out from the head and backward laterally to the thorax. The pupal integument forms the prominence on each side of the head near the eye spot, which is not visible in the photo. ×57.

Hymenoptera, is very skimpy from the point of view of representing adequately the major groups, except that the general occurrence of male haploidy seems to be well established.

Nevertheless, the few examples cited above—*Habrobracon* of the Ichneumonoidea, *Pteromalus* of the Chalcidoidea, and *Apis* of the Sphecoidea, suggest the probable wide scatter of multiple alleles among outcrossed species. On the other hand, *Telenomus* of the Proctotrupoidea and *Melittobia* of the Chalcidoidea suggest that some other method has been devised by closecrossed species to conserve fertilized eggs. The known facts suggest that the different methods of reproductive economy may be no key to the taxonomic relationships of the larger groups.

It is, however, altogether likely that certain cytological studies, in addition to determination of chromosome numbers, may be of interest and helpful in this connection. Among these may be mentioned especially the phenomena of haploid meiosis in spermatogenesis. It has been pointed out[12] that in other groups showing male haploidy quite different methods have been devised for dealing with the hereditary tendency toward formation of differentiated spermatocytes. These range from various compromises to omission of meiosis altogether. Among the hymenopterons studied cytologically there is always one abortive spermatocyte division in which the chromosomes are not divided and, except for the proctotrupoid *Telenomus*,[1] this is always the first. It would be of much interest to know among how many related species the *Telenomus* type of second division abortion prevails. The other spermatocyte division is always equal with two spermatids formed, except that in the bees—*Xylocopa* of the Xylocopidae, *Osmia* of the Megachilidae and *Apis* of the Apidae—the second division is cytoplasmically unequal and only one spermatid is formed. What happens to the second spermatocyte of the related sphecoid wasps is not known. This would be of interest in view of the fact that several vespoids, including ants, have an equal second spermatocyte division. Details such as degree of chromosome condensation for first meiosis and subsequent attenuation of the strands, differ in different species. Separation of a first spermatocyte polar body from the second spermatocyte or its ultimate reabsorption may likewise prove characteristic of various minor groups.

Summary

Wasps of the chalcidoid genus, *Melittobia* are very different from the ichneumonoid *Habrobracon* in habits, life history and sex ratio. Despite the fact that they are naturally closecrossed, female ratio is very high and no diploid males are found.

By egg count studies it has been shown for the first time that, in this genus at least, the *Habrobracon* system of sex determination with multiple alleles cannot apply.

Comparative studies of representative members of different groups of Hymenoptera suggest that, while all exhibit male haploidy and multiple sex-allelism may possibly characterize the order in general, the closecrossed species have adopted some other method of reproductive economy.

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CYTOLOGY OF EVOLUTION AND EVOLUTION OF CYTOLOGY

PROMULGATION of the cell theory slightly more than a century ago made microscopic anatomy a discipline separate from the gross anatomy of organisms. A few decades later microscopic anatomy split into histology, concerned with cellular aggregates called tissues, and cytology, concerned with cells as units. As expected from this parentage, cytology was at first a purely morphological study, relying on descriptive and comparative methods. It was inclusive and impartial: cytoplasm and cell wall, centrosome and cell nucleus seemed almost equally worthy of investigation. Discovery of the strangely complex behavior of the chromosomes in cell division, germ cell formation and fertilization began, however, to divert the attention of cytologists toward nuclear phenomena. It remained for Sutton and Boveri to point out in 1903 that the behavior of chromosomes as seen under the microscope parallels the behavior of genes inferred from Mendelian experiments. This act of insight marked a turning point; it not only set the stage for a succession of spectacular discoveries but modified the character of the science of cytology itself. It became apparent that many fundamental biological problems can be approached most successfully by a combination of cytological and genetic methods. As a consequence, a treatise on modern cytology, such as the book under review*, can no more be ignored by geneticists than cytologists can afford to ignore modern genetics. As a matter of fact, not a single one of the fourteen chapters in White's book would be out of place in a book on genetics.

Cytologists in recent years have devoted most of their efforts to the study of chromosomes and of extra-chromosomal structures which are concerned in the functioning of the chromosomal apparatus (the mitotic and meiotic mechanisms). This explains the paradox that the two most remarkable books on cytology published since the appearance of the last edition of Wilson's famous *Cell,* namely Darlington's *Recent Advances in Cytology* and White's *Animal Cytology and Evolution,* contain no accounts of the cytoplasmic structures or of general cell morphology. This omission surely does not imply a belief that the extra-chromosomal structures will not become profitable material for study in the future. The chromosomal apparatus appears, however, biologically most meaningful at present, because so many features of chromosome structure and behavior clearly have a bearing on cell physiology as reflected in heredity and evolution. No similar biological meaning is as yet known for most cytoplasmic structures; for the time being they are like inscriptions in an unknown tongue the key to which has not been discovered. It would be going too far to define modern cytology as a study of genetic problems with the aid of high-powered microscopes, and a study of cytological problems with the aid of genetic experiments, but it is a fact very clearly attested by White's book that cytology and genetics have become fused so thoroughly that no line of demarkation is discernible. The hybrid name "cytogenetics" is sometimes used to describe the compound, but what matters is not the name but the fact which it tries to express.

Aside from very ably summarizing the present state of animal cytology the book under review is significant because it strikes a balance between the divergent schools in modern cytology which tend respectively to over-generalize the uniformity of cellular processes or to underestimate this uniformity. Indeed, one of the most impressive conclusions which has emerged in the field of cy-

*WHITE, M. J. D. *Animal Cytology and Evolution.* 375 pp. $7.50. Cambridge University Press (The Macmillan Company). 1945.

tology is unquestionably that the basic processes like chromosome division, meiotic pairing, chiasma formation, and meiotic disjunction are remarkably similar in most diverse organisms, such as maize and man, lilies and grasshoppers. These similarities are the more significant since they are merely outward manifestations of even deeper similarities of the basic processes of heredity. The gene mechanism may be truly universal in the living world. Some cytologists, hypnotized as it were by the uniformity of the processes which they study, have tended to brush aside as inconsequential the very real variations found in different organisms. Other cytologists, fascinated by these variations, have tended to stress them to the point of losing sight of the fundamental unity of the biological function which the different structures perform. Dr. White quite successfully avoids both pitfalls. Throughout the book the "orthodox" course of cytological processes as well as their manifold and at times bizarre variations receive their due share of attention. Chapters XII and XIII ("Sex determination by male haploidy" and "The evolution of parthenogenesis") are entirely devoted to the variations. But these variations are never treated as though they were created by a playful god in a moment of exuberance. The author tries to understand the biological meaning of the variations which he describes, and attempts to discern the causes which deflected the evolutionary process into unusual channels. It is no fault of the author if satisfactory explanations are not always apparent. This is merely a consequence of the insufficiency of knowledge. The author's discussion serves in any case to outline a program of future research.

In reviewing the present status of animal cytology the author very ably and concisely summarizes a large amount of otherwise scattered and rather inaccessible information. The magnitude of this task can be gauged from the size of the bibliography, which occupies 37 pages of small type. Particularly to be commended is an excellent summary of the cytology of Orthoptera. The literature on Orthopteran cytology is voluminous and replete with painstakingly accurate observations. Yet, up to now, many of these observations have not been interpreted from the standpoint of modern theories. Dr. White is qualified to undertake such an interpretative task not merely by his wide general knowledge but also by his personal experience in Orthopteran cytology. His summary of Drosophila cytology is likewise good.

All in all, Dr. White has produced an excellent book which will earn him the gratitude of both teachers and advanced students of cytology, genetics and evolution.

TH. DOBZHANSKY
Columbia University

✦

Medical Genetics Marches On in the Press

Item: Discusing the quadruplets born in Baltimore two days before Christmas, an Associated Press Dispatch had this to say:

"Dr. George W. Corner, head of the department of embryology at the Carnegie Institution here, said he was conducting tests but that it would be probably two weeks before a positive determination could be made.

"After a preliminary examination in his laboratory Sunday night, the embryologist, studying the quads at the invitation of Dr. Bowyer, concluded that *one boy and the girl were identical twins,* while the two other boys were separate and distinct babies."

No doubt Dr. Corner was as surprised—and surely as edified as other informed readers who marveled at this priceless pearl of biological wisdom.

Item: The Washington Post (Jan. 11, 1947, p. 1), in discussing the arrival of the Skoffard triplets—all girls—broke new ground regarding what we may expect when infants come packaged in trios:

"Triplets occur about one in 8,000 maternity cases. *Generally all three babies are girls,* and less frequently, the sexes are mixed. Triplet boys are extremely rare."

The typical sex-score of the 263 sets of triplets born in the U. S. in 1940 is thus given by the Census Bureau:

Three males—65 sets; 2 males, 1 female—53 sets; 1 female, 2 males—70 sets; 3 females—73 sets.

CATTLE BREEDING IN INDIA

The Development of Milk Production in Two Indian Breeds of Cattle

FRED B. OGILVIE
American Delhi Military Area Command

THE Imperial Agricultural Research Institute, New Delhi, India has for some years been engaged in developing milk production in two breeds of Indian Cattle. The progress made has been remarkable, and the lines along which the work has developed will be of interest to cattle breeders in other countries. The two breeds used in this project are the Sahiwal and the Tharparkar.*

The Sahiwal breed is native to the Punjab, and the Tharparkar comes from the desert regions of Sind. The rainfall of the home tracts seldom exceeds ten inches, and the temperature normally varies from zero at night in winter to 118° F. in the shade in summer. These conditions make the project of especial interest to cattle breeders in the southern and southwestern United States.

Work with the Sahiwal herd started 40 years ago, at Pusa, in the province of Bihar, but the greatest progress has been made during the last 14 years commencing with the introduction of a new system of management. The same plan has applied to the Tharparkar herd located at Karnal, beginning nine years ago.

The strength of both herds is maintained at about 275 head. About 65 cows are maintained regularly in milk and 25 are dry. All heifer and bull calves are reared. The former are all tested for milk production and out of the latter the herd stud bulls are selected. These are all progeny tested. The remainder are used in village cattle improvement schemes organized by the various Provincial or State Governments.

The calving period aimed at is 13 months. Lactation periods are fixed at 306 days. Dystocia is rare in both breeds. Calves are all weaned and pail fed. Birth weight averages 50 pounds (males slightly heavier than females). Feeding is arranged for at a level of nutrition to yield a gain in live weight of one pound per day. Milk containing normally five per cent fat is standardized to 3½ per cent fat and fed for the first four months at increasing quantities up to eight pounds per day; then separated milk is substituted. Milk feeding is discontinued after six months with bull calves and eight months with cow calves.

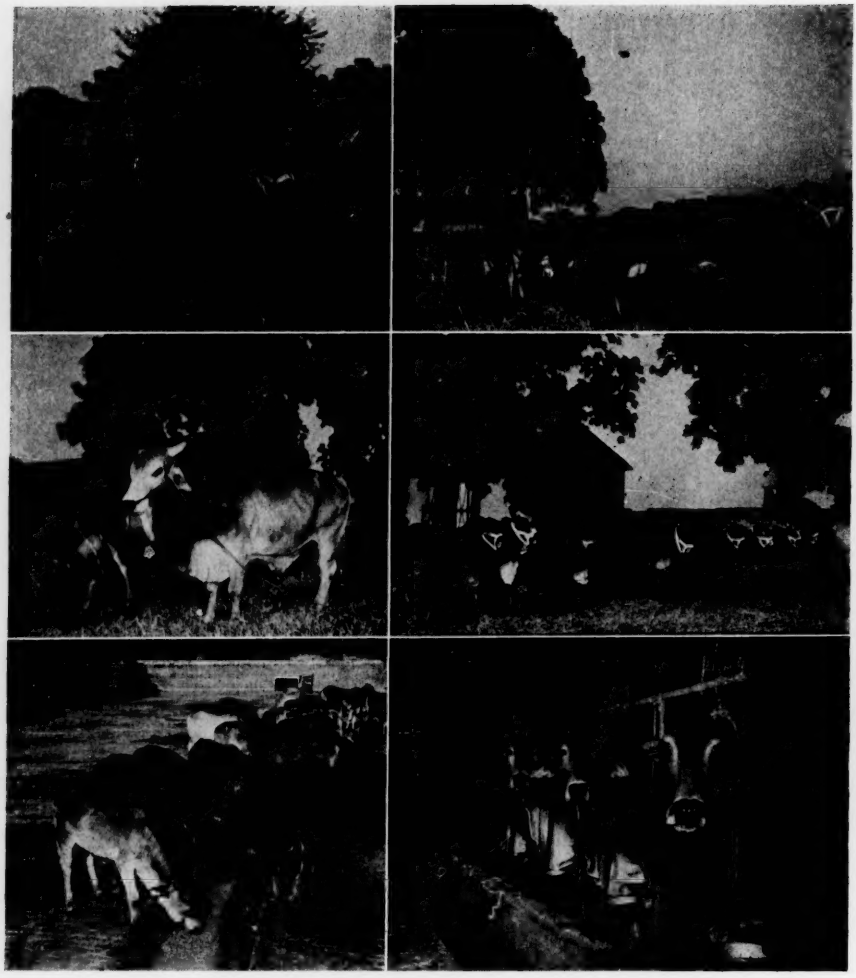
Longevity is characteristic of both herds. Table I shows the individual life time yields of six fourteen-year-old Sahiwals, and two Tharparkars, eleven and twelve years old respectively. Some of these cows are shown in Figures 10 and 11. All were carrying calves at the time these figures were compiled.

The initial rate of gain is steadily maintained and heifers are mated when they reach 600 pounds weight, at about 19 months of age. Their first calves are born at about 28½ months. Only cows which yield 6,000 pounds or over in the first or second lactations are re-

TABLE I. Fecundity and Milk Yield

Sahiwals	*Yield to date, lbs.*	*Lactations*	*Average yield per day*
Bilamba	78,070	8	22
Charoochi	68,561	8	19
Chansuri	82,176	9	21
Birengee	57,194	7	16
Chengee	54,136	7	15
Laruli	47,665	5	16.5
Tharparkars			
Phijji	44,428	6	16
Machakni	52,000	6	16.5

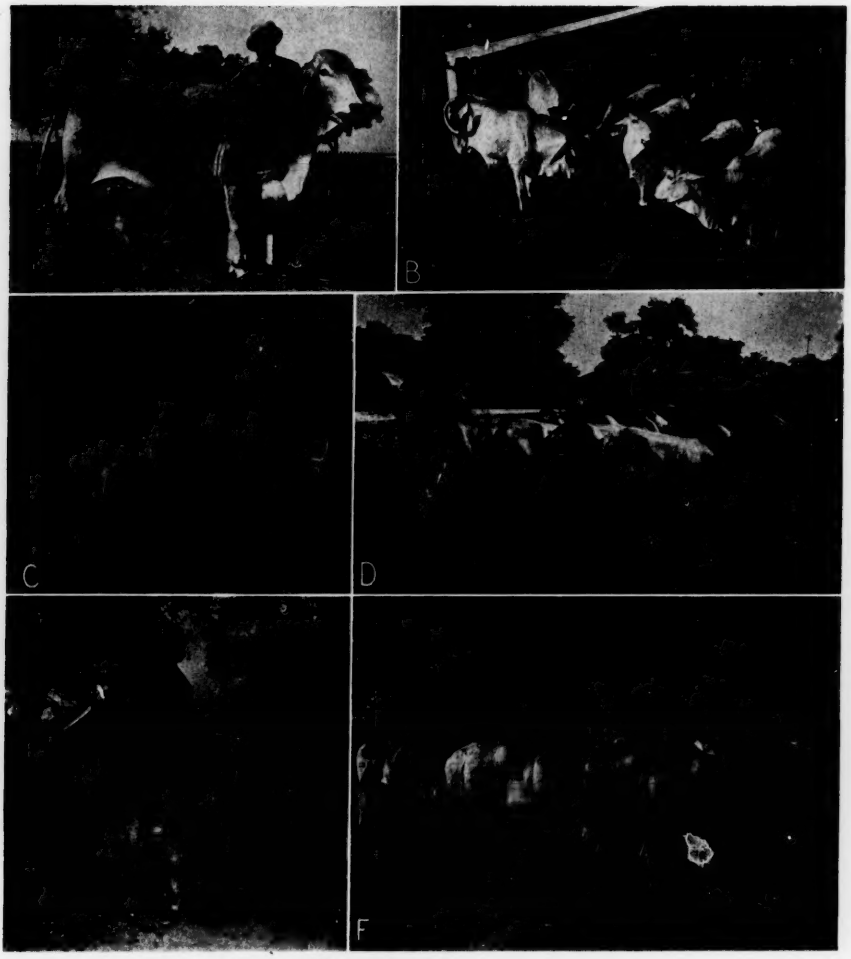
*For a detailed description of these and other breeds see Phillips' account of the cattle of India. *Jour. Hered.* 35:9. 1944.



SELECT SAHIWAL CATTLE AT PUSA

Figure 10

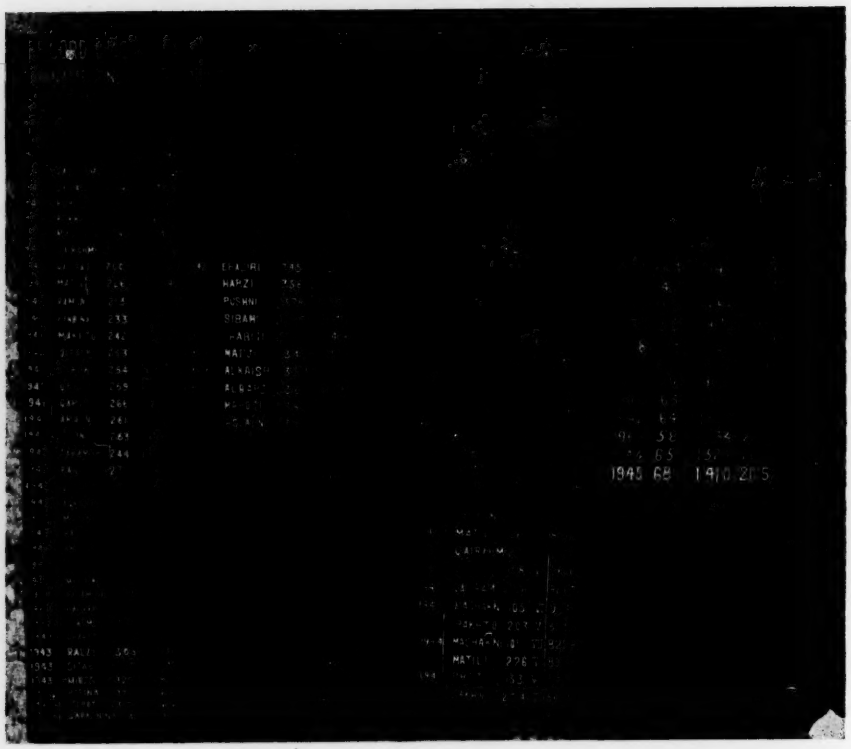
A—Mr. C. H. Parr, Imperial Agriculturist points out to the author the fine points of an outstanding Sahiwal cow—Bilamba. She was 14 years old and in calf at that time. Her life time yield then was 78,070 lbs. in eight lactations, an overall yield per day of 22 lbs. Amba, her dam, yielded over 9,000 lbs. average per lactation (306-day period). She produced 12 calves and is a foundation cow to whom about 25 percent of the Sahiwal herd is related. *B*—Five linebred Sahiwal cows. *C*—Sahiwal bull Genesh, a progeny tested bull which has produced many high yielding progeny. *D*—Some selections from the Raseeli line which has produced a number of very high yielders. *E*—A group of Sahiwal calves at feed trough in the calf lot at Pusa. *F*—Sahiwal cows in stanchions at Pusa Dairy Barn.



THARPARKAR CATTLE

Figure 11

A—A Tharparkar cow which has recovered from foot and mouth disease, though still showing a rough coat. *B*—A group of Tharparkar calves at feed trough in Karnal calf lot. *C*—Mapji shown behind her dam Phijji. Mapji yielded 7,009 lbs. in her first lactation. She clearly illustrates the trend toward the dairy type which accompanies the selection for and development of milk yield. Her dam Phijji (born 1935, now, in 1945, to calve for seventh time) has yielded over 9,000 lbs. in each of two lactations and over 10,000 lbs. in one. *D*—String of young Tharparkar cows by Alam (half brother of Tikka out of Fakira) each of which has produced from 5,000 to 7,000 lbs. in her first lactation. *E*—Balwant (born 1939 by Quais out of Katila—best yield 9,064 lbs.) now on progeny test. *F*—Tikka with five of his female progeny, two of which produced over 8,000 lbs. in their first lactation: the other three over 6,500 lbs. They show excellent type and sound constitution and each weighed about 900 lbs. at first calving.



A RECORD OF PROGRESS
Figure 12

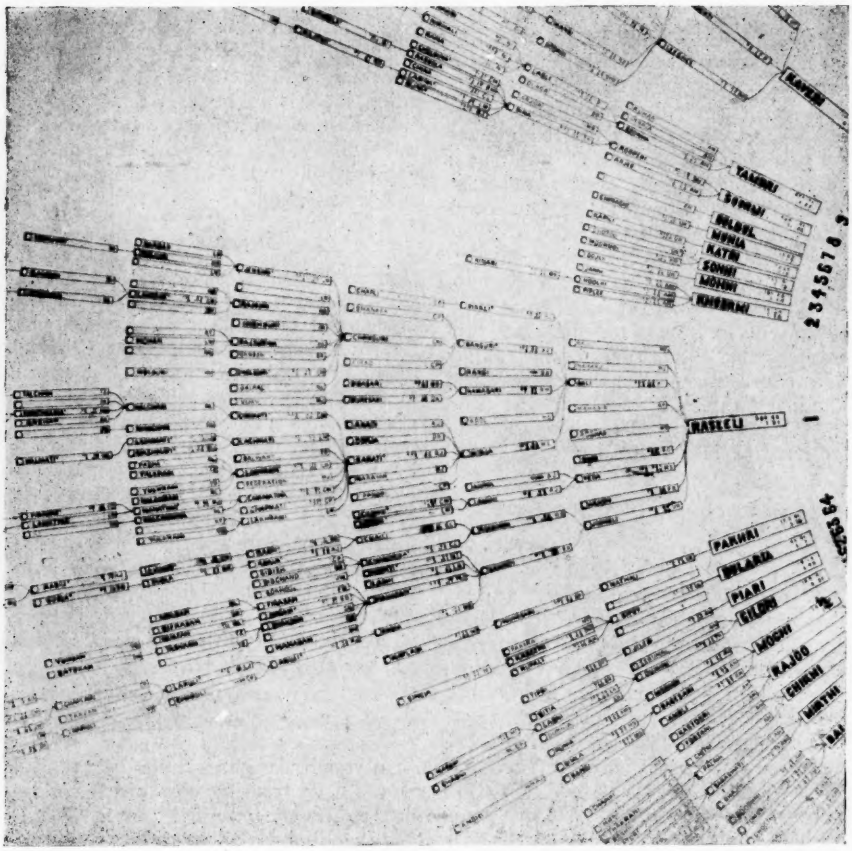
Herd record charts of the Tharparkar Herd at Karnal. The individual records are shown at the left, and the yearly averages for the herd at the right. The consistent rise in annual yield shows clearly the results of the last fifteen years' program of line breeding, selection and management.

tained in the herd for later selection. First lactation yield is not a sufficiently accurate index of ultimate production capacity. The average daily yield for the herds is about 20 pounds in a 306 day lactation period. The overall average wet and dry period milk yield is 14.5 pounds.

Management Practice

The plan of management now in operation in this experiment was introduced in 1932 by Mr. Wynne Sayer. Later the plan has been continued under the direction of Mr. C. H. Parr, Agriculturist of the Imperial Agricultural Research Institute. To Mr. Parr the author is deeply indebted for his co-operation, and for the many courtesies extended him which made the preparation of this article possible.

The following are some of the notable features of the plan: (1) Prenatal milking of all heifers and cows. Heifers' udders are gently massaged for a month and cows for a fortnight before calving and both heifers and cows are regularly milked as soon as milk secretion starts. Heifers sometimes give as much as 20 pounds of milk per day before calving and cows 25 pounds. The milk at calving is thus normal milk, not the usual colostrum. (2) Calves are separated at birth and the mothers are not allowed



BOVINE ROTARY
Figure 13

An interesting method of showing line of descent in the Sahiwal herd at Pusa. This chart is on a large circular canvas and may be rotated to any cow one desires to trace back on the maternal line. The 64 original cows of the herd are arranged in the inner circle. The matings of each cow, and the milk yield of her descendants, are shown.

to see, smell or lick the calf. Calves are dried by hand. The meconium is removed by an ounce of linseed oil given with a little milk a few hours after birth. This method cuts across the strong maternity instinct of Indian breeds, which when allowed normal expression tends to inhibit the free flow of milk to the milker. Thus, about 1500 calves have been reared without colostrum. The losses from all causes have averaged seven per cent, which compares favorably with colostrum fed calves in well managed herds. (3) Cows are milked four times daily. Milking more frequently than two times stimulates milk secretion and results in the development of a curve of milk production similar to that of cows of the long established dairy breeds. The complete absence of mastitis in both herds seems to be one of the biggest benefits of this extra care. Not a cow in either herd had a non-functional quarter of the udder as a result of this disease.

Breeding

The herds are line bred. More than 75 per cent of the present Tharparkar herd is descended from three sires—Kurnol, Kurwell and Bringmore, through three of their sons (Maharaj, Ranfurly and Umpire Pavern), and from their three grandsons (Tikka, Quais and Ijaz). Tikka by Maharaj out of Kakiran (best yield 7,702 lbs.) is shown in Figure 11*F* with five of his female progeny. Of these cows, two produced over 8000 pounds of milk in their first lactation and the other three 6500 pounds. They show excellent, sound constitution. Each weighed about 900 pounds at first calving. The pedigree of Urji is typical of the line breeding adopted.

♀ Urji
- Umpire
  - Bringmore
  - Katili
- Birji
  - Bringmore
  - No. 42

A daughter of Maharaj, Mapji is shown behind her dam Phijji (Figure 11*C*) out of Rajji by Ranfurly. Mapji has a dairy type conformation. She yielded 7009 pounds in her first lactation, calving at 26 months. It should be noted that the milk of both these breeds averages five per cent.

A young Tharparkar bull, Balwant (Figure 11*E*), born in 1939 by Quais out of Katili (best yield 9064 lb.) is now under progeny test. Figure 11*D* shows a string of young cows by Alam, half brother of Tikka, out of Fakira. All of these cows produced from 6000 to 7000 pounds of milk in their first lactation.

The group of Sahiwal cows in their stanchions (Figure 10 *F*) all have lactation records of better than 8000 lbs.

In Figure 10*C*, progeny tested Sahiwal bull Genesh with a string of his progeny illustrates uniformity of type and constitution.

Discussion

Line breeding, selection and herd management in herds of the two Indian breeds, the Tharparkar and the Sahiwal, clearly indicate that both of these breeds might be valuable in the southern United States as they resist high diurnal temperatures and extreme variations in temperature. The Sahiwal shows confirmation tending toward a dual type. Disposition of cows of both breeds is very good. A stranger can give one of them a pat and she will follow him around like an affectionate dog. Prenatal milking or milking four times a day during lactation seems to insure elimination of mastitis in these two herds as they are mastitis free.

Foot and mouth disease, though usually of a mild form is omnipresent and, following an attack, a cow may never be of any value for production. Figure 11*A* shows a Tharparkar cow which has recovered from foot and mouth disease but is still showing a rough coat. There is no contagious abortion in either of these herds. Outbreaks of bipolar infection, calf pneumonia, and sterility in cows are the chief disease problems.

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1946 Breaks Birth-Record

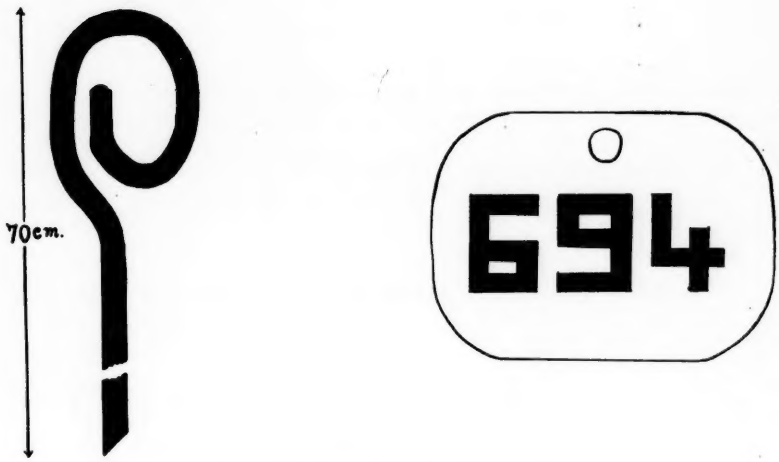
The U. S. Public Health Service announces provisionally that 3,260,000 births were registered in the United States in 1946, surpassing the previous high of 2,934.860 recorded in 1943 by 11 per cent. The provisional birth rate for the past year was 23.3 per 1,000 population including the armed forces overseas, or nearly 19 per cent above the rate of 19.6 for 1945 and 8 per cent higher than the wartime peak of 21.5 for 1943. In 1943 the birth rate was the highest recorded since 1924.

The provisional death rate is estimated at 10.1 per 1,000 population excluding the armed forces overseas as compared with the final rate of 10.6 for 1945.

The provisional infant mortality rate for the reporting area of 46 States and the District of Columbia was 36.1, or 3.7 per cent lower than the corresponding rate of 37.5 infant deaths per 1,000 live births for 1945.

THREE USEFUL GADGETS FOR PLANT BREEDERS

I. A Numbered Stake for Marking Field Experiments



LEGIBLE, INDELIBLE, PERENNIAL

Figure 14

MANY types of stakes are used by plant breeders to mark the different varieties of plants in their field plots. Wood, wire, steel, tin, cardboard, and other materials are cut, bent and otherwise shaped into many sizes and forms. The purpose of the stake is well defined, but the fulfillment is usually not attained. In a recent trip in which stakes were observed in many different experiment stations, it was found that the all-important number is frequently inconspicuous, illegible or invisible. It is not uncommon to find a large, white, wooden stake that can be seen from a considerable distance, but with a tiny number that can only be read on close scrutiny. In other cases the number may be on a shipping tag which defies inspection in all but the mildest breeze.

No attempt will be made here to describe the different types of stakes nor to evaluate their usefulness. In any case, no one stake meets all the requirements of the different uses.

Two years ago a wire stake with a metal tag was devised for use in our experiment station and has given favorable results in heavy clay soils, sandy soils, and inundated soils to mark rice, corn, sesame, beans, forage, and other crops. At the Third Interamerican Agricultural Congress of 1945, the stakes were demonstrated to visitors from many countries and some of the men made drawings of them. In the belief that this stake, or one similar to it, may prove useful to others, the accompanying sketch is presented (Figure 14).

A number 8 or 9 wire 70 centimeters long is bent around a form (consisting of many nails pounded close together in hard wood and later deheaded) to give the desired shape to support the tag. A

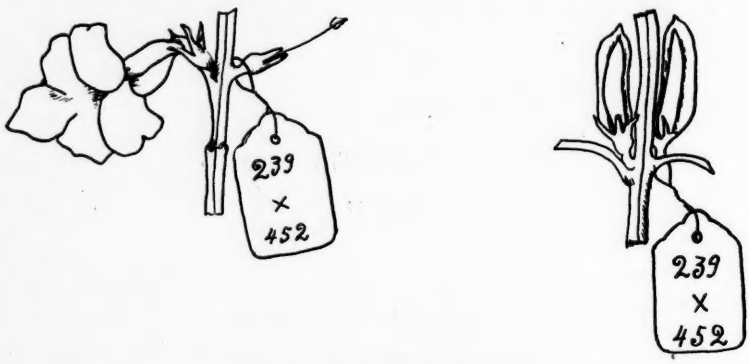
significant feature of the system is that the metal tag is put onto the "head" of the stake by running the tip of the stake through the hole in the tag and coming up from the bottom. No pliers are necessary. If by any chance the number plate is blown off it is still anchored to the ground because it must go off the way it came on.

The metal tags may be cut in rectangular form from thin sheet iron. (Ours are made of tin can lids from an extinct meat packing company.) They are dipped into white paint and later the number is put on both sides with black paint. A hole slightly larger than the wire support is punched in the top center.

The principal advantages of this type of stake are: 1. the number is plainly visible from either side (especially useful in taking seedling notes); 2. the stake can easily be pushed into the ground; 3. it is of permanent value; 4. the number is easily fastened to the support; and 5. the number stays with the stake in the field in spite of wind, but can be readily removed for storage by slipping it off the bottom of the wire.

More than likely some one will think of a way of improving this method of marking field plots. Any suggestions will be very much appreciated.

II. A Useful Tag for Marking Artificial Crosses in Sesame



WITH A TWIST OF THE FIST

Figure 15

THE common string tag used by most plant breeders to mark crosses in plants proved to be cumbersome and often the source of error in the hybridization work with sesame. When the rapid methods of making crosses* in this crop (involving the use of gelatine capsules) is employed on a large scale, the task of fastening the string tag by putting it around the stalk and slipping the cardboard between the two strands becomes too tedious and considerable time is lost. Worse than that, the string is often erroneously placed in the axil of the unused flower on the opposite side of the stalk. At harvest time there is no way of telling which seed capsule contains the hybrid seeds.

To avoid these difficulties, another type of tag was designed and has been

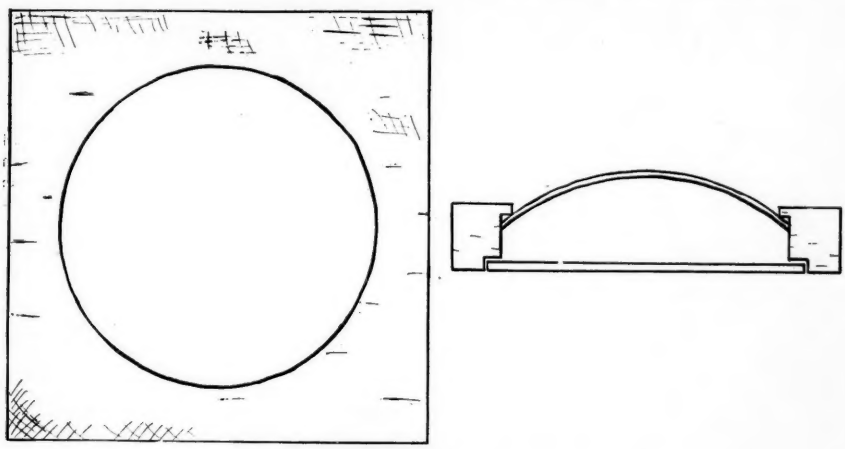
*LANGHAM, D. G. *Jour. Hered.* 35:255-256. 1944.

giving favorable results, not only in sesame but also in beans and tomatoes. In the hope that it may be useful to other workers, it is briefly described here.

As can be seen in the diagram (Figure 15), the string of the ordinary tag is replaced by a fine insulated copper wire (N° 27), and a wire circle is made to place over the pollinated flower. Once the circle is in position around the petiole, pressure is applied by the thumb and forefinger and the circular opening is reduced to an irregular shape, considerably smaller in size, to resist removal by wind. When the seed capsule develops it can not be confused with any other because of the wire tag around the petiole.

This method has been successfully used during the past two years. Considerable time and effort have been saved, and the errors were reduced to a minimum. The writer has arranged to have these made for him in quantity by the Dennison Company.

III. An Exhibition Plate for Seeds, Crystals and Other Materials



CRYSTAL CLEAR

Figure 16

IT was found quite by accident that by putting an ordinary watch glass used in chemistry over a pile of seeds and applying pressure with a certain amount of rotary movement, a particularly good view of the seeds was obtained, giving the impression of their being suspended over the surface of the table. Perhaps the reason for this is the fact that the glass over the seeds facilitates their dispersion with the more flattened surface against the glass. This is quite different from the case of putting a lot of seeds in a jar or other cylindrical tube in which many of the seeds have their tip ends against the glass.

In order to prepare a permanent exhibit of seeds with a watch glass, a wooden support was designed (Figure 16) which permits the seeds to be inserted from the back and pressure applied against them with the circular cover. The size of the holder and the watch glass is varied according to the size of the seeds or other materials to be demonstrated. A plate with a 3½ inch diameter like the one shown in the sketch has proven to be desirable for corn, rice and similar grains.

For loading, the frame is held upside down and seeds packed into it until pressure is needed to force the lid into

place. Care should be taken to see that the seeds assume a flattened position against the glass. Then the lid is fastened by sealing with a gummed paper that overlaps the lid and the border of the frame. Each exhibition plate is separate and can be individually placed within the group to give the most desirable contrast with other units in the display.

Perhaps the principal advantage of this type of plate is that almost every laboratory has watch glasses available in different sizes, and any carpenter can prepare the frame.

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Head of Genetics Department
Instituto Nacional de Agricultura
Maracay, Venezuela, S. A.

✦

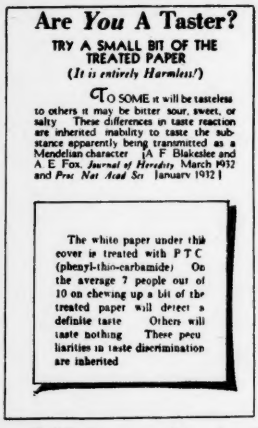
Jargon of Science

The failure of the social sciences has been a part of the failure of our whole scheme of education, and what I have to say about them might be said of other studies with only a few changes. Failure to improve the social sciences now may mean that they will sink to that level of utter futility which characterized the world of learning in Roman days. Two related troubles may be separated out for discussion. Each social science has developed a jargon of its own to so high a degree that mutual understanding is impossible. Jargon should be eradicated. If this were done, the social sciences might be able to take the next step, which is union in a common purpose.

Though the students of one science ought to be able to understand those of another, economists write an economics jargon and sociologists a sociological jargon, instead of in terms the historian, the political scientist and the layman can understand. This statement is not intended to imply that economists and sociologists are the only sinners. Until about a century ago, books in all fields were written in language open to the layman. Hume wrote simply and clearly even about recondite matters, there is no misunderstanding what he meant. The *Essay Concerning Population* of Malthus may be read easily even by the non-specialist. Now all that is gone. Jargon has been so highly developed that each writer tends to express himself in words which he alone knows the meaning of. For a remedy, either each reader must learn the language of each writer, or, what is simpler, each writer must be familiar enough with one common language to know how to avoid jargon. The best test of language is that intelligibility to the layman which the latter alternative implies. . . .

There is no clear writing and no mutual understanding, then, without clear ideas. In the United States, the processes by which ideas are sorted out and made clear have been neglected. This is one reason for the rise of jargon; it tends to conceal imperfections of thought. It creates an illusion of profundity where there is none. Many students are unaware that clearcut ideas are possible. . . .

Through clarification of thought and enlargement of view students would, at the same time, learn how to recognize real problems, how to formulate them and how to deal with them. We talk a lot about the Negro "problem" and about the labor "problem." What do we do with these "problems?" We accumulate data. What do we do with the data? We can hardly do anything with them; they are much more likely to do something to us. An accumulation of data can do little more than stultify the accumulator. But, what would the case be if the student knew how to formulate genuine problems? He would know then that a problem is nothing more than an unanswered question. There is no Negro problem"; there is no labor "problem." There are, however, problems concerning Negroes and problems concerning laborers, as there are problems concerning many other matters. One such problem might be "Are Negro factory workers more or less susceptible to industrial diseases than other classes of workers?" To this there should be a simple statistical solution, after the terms have been defined. Once clear-cut problems are set up, once clear-cut questions are asked, the methods of the social sciences are adequate, if a solution be possible at all.—Dr. Stanley D. Dodge, *Science*, April 27, 1945.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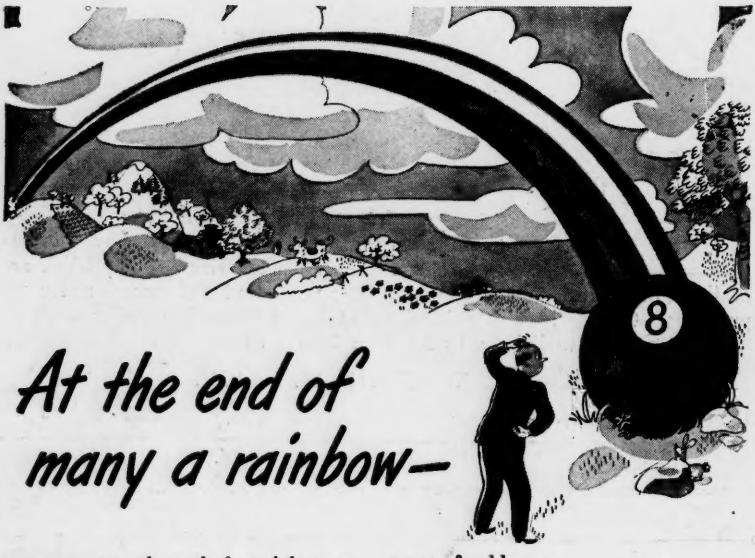

At the end of many a rainbow—

IF YOU GO to the end of a rainbow, so the fairy tales say, you'll find a pot of gold.

Of course, no grownup believes this. But it's surprising how many people believe what amounts to the same thing.

That is, many of us have a dreamy notion that somewhere, sometime, we'll come upon a good deal of money. We go along from day to day, believing that *somehow* our financial future will take care of itself.

Unfortunately, this sort of rainbow-chasing is much more apt to make you wind up behind the eight ball than with a pot of gold.

When you come right down to it, the only sure-fire way the average man can plan his financial security is through saving—and saving regularly.

One of the soundest, most convenient ways to save is by buying U. S. Savings Bonds through the Payroll Plan.

These bonds are the safest in the world. They mount up fast. And in just 10 years, they pay you $4 back for every $3 you put in!

P. S. You can buy U. S. Savings Bonds at any bank or post office, too.

SAVE THE EASY WAY... BUY YOUR BONDS THROUGH PAYROLL SAVINGS